WHAT IS CLAIMED IS:

1	1. A method for efficiently transferring a spacecraft to a desired orbit, the
2	method comprising:
3	computing a continuous-firing thrust trajectory to achieve an orbit transfer;
4	computing thrust effectiveness values for time intervals over the continuous-
5	firing thrust trajectory;
6	comparing the thrust effectiveness values with a thrust effectiveness threshold
7	value; and
8	computing an intermittent-firing thrust trajectory to achieve the orbit transfer,
9	the intermittent-firing thrust trajectory comprising thruster-on regions where the thrust
10	effectiveness value is about or above the thrust effectiveness threshold value, and thruster-off
11	regions where the thrust effectiveness value is below the thrust effectiveness threshold value.
1	2. The method as recited in claim 1, wherein computing the intermittent-
2	firing thrust trajectory comprises:
3	determining one or more thruster-off regions for a first orbit revolution;
4	computing a first updated thrust trajectory for the entire orbit transfer using the
5	thruster-off regions identified for the first orbit revolution in the calculation;
6	determining one or more thruster-off regions for a second orbit revolution
7	using the first updated trajectory;
8	computing a second updated thrust trajectory for the entire orbit transfer using
9	the thruster-off regions identified for the first and the second orbit revolutions in the
10	calculation; and
11	continue computing thruster-off regions for each successive orbit revolution
12	and further updated thrust trajectories until a final intermittent-firing thrust trajectory is
13	determined for all orbits of the entire orbit transfer.
1	3. The method as recited in claim 2, wherein the thruster-on regions, the
2	thruster-off regions and the final intermittent-firing thrust trajectory are determined prior to
3	carrying out the orbit transfer.
1	4. The method as recited in claim 1, wherein the thrust effectiveness
2	value is calculated according to the equation:

$$\Gamma(t) = 1 - \frac{\lambda_6 \, \dot{F}}{\lambda^T \, \dot{z}}$$

- 5. The method as recited in claim 1, wherein prior to comparing the thrust effectiveness value with a thrust effectiveness threshold value, the method further comprises determining the thrust effectiveness threshold value.
- 1 6. The method as recited in claim 5, wherein the thrust effectiveness 2 threshold value is a function of thruster shut-off time, fuel savings and increase in orbit 3 transfer time.
- 7. The method as recited in claim 5, wherein the thrust effectiveness threshold value is denoted Γ_0 and can be solved for by evaluating the integrals

$$T_{1}(\Gamma_{0}) = \int_{0}^{T} \eta \Gamma dt \qquad \eta = 1 \quad \text{if } \Gamma \leq \Gamma_{0}$$

$$T_{2}(\Gamma_{0}) = \int_{0}^{T} \eta (1 - \Gamma) dt \qquad \text{where,} \qquad \eta = 0 \quad \text{if } \Gamma > \Gamma_{0}$$

- for values of Γ_0 between 0 and 1 with a reasonable resolution, wherein T_1 gives a relationship between the thrust effectiveness threshold value Γ_0 and a total increase in the orbit transfer time, and wherein T_2 gives a relationship between the thrust effectiveness threshold value Γ_0 and a reduction in firing time.
- 1 8. The method as recited in claim 1, wherein an amount of fuel required 2 to perform the orbit transfer is lower than the amount of fuel required to perform a time-3 optimal continuous-firing orbit transfer.
- 1 9. The method as recited in claim 1, wherein an increase in transfer time 2 compared to a time-optimal continuous firing orbit transfer is minimized.
- 1 10. The method as recited in claim 1, wherein the thrusters are not fired 2 when the orbit change is insensitive to thrusting.
- 1 1. The method as recited in claim 1, wherein the thrusters are not fired when a required rate of change of thrust trajectory direction is too large for the spacecraft to follow.

1	12. The method as recited in claim 1, wherein the change in orbit
2	comprises a transfer from a launch vehicle injection orbit to a final mission orbit.
1	13. The method as recited in claim 1, wherein the thrusters are not fired
2	when continuously firing the thrusters will not reduce the velocity change required to
3	complete the orbit transfer by at least a threshold amount.
1	14. A spacecraft orbit transfer system adapted to transfer the spacecraft
2	from a first orbit to a second orbit, the system comprising:
3	spacecraft thrusters; and
4	at least one controller adapted to control the spacecraft orbit transfer;
5	the spacecraft orbit transfer system being adapted to:
6	compute a continuous-firing thrust trajectory to achieve an entire orbit
7	transfer;
8	compute thrust effectiveness values for time intervals over the
9	continuous-firing thrust trajectory;
10	compare the thrust effectiveness values with a thrust effectiveness
11	threshold value; and
12	compute an intermittent-firing thrust trajectory to achieve the orbit
13	transfer, the intermittent-firing thrust trajectory comprising thruster-on regions where
14	the thrust effectiveness value is at about or above the thrust effectiveness threshold
15	value and thruster-off regions where the thrust effectiveness value is below the thrust
16	effectiveness threshold value, wherein the spacecraft thrusters are turned-on during
17	the thruster-on regions, and the spacecraft thrusters are turned-off during the thruster-
18	off regions.
1	15. The system as recited in claim 14, wherein the at least one controller is
2	selected from the group consisting of at least one controller on the spacecraft, at least one
3	controller on the earth, and a combination of at least controller on the spacecraft and at least
4	one controller on the earth.
1	16. The system as recited in claim 14, wherein the spacecraft orbit transfer
2	system computes the intermittent-firing thrust trajectory by:
3	determining one or more thruster-off regions for a first orbit revolution;

- computing a first updated thrust trajectory for the entire orbit transfer using the thruster-off regions identified for the first orbit revolution in the calculation;
- determining one or more thruster-off regions for a second orbit revolution
 using the first updated trajectory;
- computing a second updated thrust trajectory for the entire orbit transfer using
 the thruster-off regions identified for the first and the second orbit revolutions in the
 calculation; and
- 11 continue computing thruster-off regions for each successive orbit revolution 12 and further updated thrust trajectories until a final intermittent-firing thrust trajectory is 13 determined for all orbits of the entire orbit transfer.
- 1 17. The system as recited in claim 16, wherein the spacecraft orbit transfer system determines the thruster-on regions, the thruster-off regions and the final intermittent-firing thrust trajectory prior to carrying out the orbit transfer.
- 1 18. The system as recited in claim 14, wherein the thrust effectiveness value is calculated according to the equation:

$$\Gamma(t) = 1 - \frac{\lambda_6 \, \dot{F}}{\lambda^T \, \dot{z}}$$

- 1 19. The system as recited in claim 14, wherein the spacecraft orbit transfer system determines the thrust effectiveness threshold value prior to comparing the thrust effectiveness value with a thrust effectiveness threshold value.
- 1 20. The system as recited in claim 19, wherein the thrust effectiveness 2 threshold value is a function of thruster shut-off time, fuel savings and increase in orbit 3 transfer time.
- 1 21. The system as recited in claim 19, wherein the thrust effectiveness 2 threshold value is denoted Γ_0 and can be solved for by evaluating the integrals

$$T_{1}(\Gamma_{0}) = \int_{0}^{T} \eta \Gamma dt \qquad \eta = 1 \quad \text{if } \Gamma \leq \Gamma_{0}$$

$$T_{2}(\Gamma_{0}) = \int_{0}^{T} \eta (1 - \Gamma) dt \qquad \text{where,} \qquad \eta = 0 \quad \text{if } \Gamma > \Gamma_{0}$$

4	for values of I_0 between 0 and 1 with a reasonable resolution, wherein T_1
5	gives a relationship between the thrust effectiveness threshold value Γ_0 and a total increase in
6	the orbit transfer time, and wherein T_2 gives a relationship between the thrust effectiveness
7	threshold value Γ_0 and a reduction in firing time.
1	22. The system as recited in claim 14, wherein an amount of fuel required
2	to perform the orbit transfer is lower than the amount of fuel required to perform a time-
3	optimal continuous-firing orbit transfer.
1	23. The system as recited in claim 14, wherein an increase in transfer time
2	compared to a time-optimal continuous firing orbit transfer is minimized.
1	24. The system as recited in claim 14, wherein the thrusters are not fired
2	when the spacecraft orbit change is insensitive to thrusting.
1	25. The system as recited in claim 14, wherein the thrusters are not fired
2	when a required rate of change of thrust trajectory direction is too large for the spacecraft to
3	follow.
1	26. The system as recited in claim 14, wherein the first orbit comprises a
2	launch vehicle injection orbit and the second orbit comprises a final mission orbit.
1	27. The system as recited in claim 14, wherein the thrusters are not fired
2	when continuously firing the thrusters will not reduce the velocity change required to
3	complete the orbit transfer by at least a threshold amount.
1	28. A spacecraft adapted to transfer from a first orbit to a second orbit,
2	comprising:
3	spacecraft thrusters; and
4	an orbit transfer system adapted to transfer the spacecraft from a first orbit to a
5	second orbit, the orbit transfer system comprising at least one controller adapted to control
6	the spacecraft orbit transfer, the spacecraft orbit transfer system being adapted to:
7	compute a continuous-firing thrust trajectory to achieve an entire orbit
8	transfer;
9	compute thrust effectiveness values for time intervals over the
10	continuous-firing thrust trajectory;

11	compare the thrust effectiveness values with a thrust effectiveness
12	threshold value; and
13	compute an intermittent-firing thrust trajectory to achieve the orbit
14	transfer, the intermittent-firing thrust trajectory comprising thruster-on regions where
15	the thrust effectiveness value is at about or above the thrust effectiveness threshold
16	value and thruster-off regions where the thrust effectiveness value is below the thrust
17	effectiveness threshold value, wherein the spacecraft thrusters are turned-on during
18	the thruster-on regions, and the spacecraft thrusters are turned-off during the thruster-
19	off regions.
1	29. The spacecraft as recited in claim 28, wherein the at least one
2	controller is selected from the group consisting of at least one controller on the spacecraft, at
3	least one controller on the earth, and a combination of at least controller on the spacecraft and
4	at least one controller on the earth.
1	30. The spacecraft as recited in claim 28, wherein the orbit transfer system
2	computes the intermittent-firing thrust trajectory by:
3	determining one or more thruster-off regions for a first orbit revolution;
4	computing a first updated thrust trajectory for the entire orbit transfer using the
5	thruster-off regions identified for the first orbit revolution in the calculation;
6	determining one or more thruster-off regions for a second orbit revolution
7	using the first updated trajectory;
8	computing a second updated thrust trajectory for the entire orbit transfer using
9	the thruster-off regions identified for the first and the second orbit revolutions in the
10	calculation; and
11	continue computing thruster-off regions for each successive orbit revolution
12	and further updated thrust trajectories until a final intermittent-firing thrust trajectory is
13	determined for all orbits of the entire orbit transfer.
1	31. A method for transferring a spacecraft from a first orbit to a second
2	orbit, comprising:
3	calculating thruster-off regions within the orbit transfer in which it is efficient
4	to turn-off spacecraft thrusters; and
5	turning off the spacecraft thrusters in the thruster-off regions